INSTITUTE FOR DEFENSE ANALYSIS

IDA Document D-2508

MOUT Situational Awareness Experiments

D. F. DeRiggi, Project Leader
R. W. Carpenter
K. L. Green
W. W. Lin
T. M. Stone

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (FROM - TO)
01-12-2000	Final	xx-xx-2000 to xx-xx-2000

4. TITLE AND SUBTITLE
MOUT Situational Awareness Experiments
Unclassified

5a. CONTRACT NUMBER
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
DeRiggi, Dennis F. ;
Carpenter, Richard W. ;
Green, Keith L. ;
Lin, Windsor W. ;
Stone, Timothy M. ;

5d. PROJECT NUMBER
5e. TASK NUMBER
5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME AND ADDRESS
Institute for Defense Analyses
1801 N. Beauregard St.
Alexandria, VA22311-1772

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS
FFRDC Programs
2001 N. Beauregard St.
Alexandria, VA22311-1772

10. SPONSOR/MONITOR'S ACRONYM(S)
11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APUBLIC RELEASE
,

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Military Operations in Urban Terrain present challenges that differ from those of conventional warfare. Often these arise because only limited force can be applied. To compensate, precise information about an opponent?s location and condition is desired. This experiment demonstrates the value of such information when an occupied building is approached by coordinated Blue force, but calls into question its utility once inside.

15. SUBJECT TERMS
MOUT; situtational awareness; dismounted infantry; experimental design

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	Public Release	54	Fenster, Lynn lfenster@dtic.mil
Unclassified	Unclassified	Unclassified			19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007

PREFACE

This document was prepared under Central Research project (CRP) 1072. It summarizes the results of a simulated MOUT experiment in which situational awareness was varied in a controlled manner. Using the Soldier Visualization Station (SVS) and Dismounted Infantry Semi-Automated Force (DISAF) simulations, this experiment was conducted in the IDA Simulation Center during the spring and summer of 2000.

The authors would like to thank Dr. John M. Gray and Dr. Robert F. Richbourg for their reviews of this document. Their insight provided much-needed guidance. The authors would also like to thank Mr. Stanley A. Weber for his technical assistance in maintaining the simulation equipment.

(This page is intentionally blank.)

CONTENTS

Appendix

LIST OF FIGURES

(This page is intentionally blank.)

LIST OF TABLES

(This page is intentionally blank.)

EXECUTIVE SUMMARY

A. BACKGROUND

In the past decade, the United States has taken on a number of peacekeeping roles and missions. As this trend is likely to continue for the foreseeable future, Military Operations in Urban Terrain (MOUT) have become an area of intense study and analysis. MOUT sites for training are planned or have been constructed at several military installations. These include Fort Benning, Camp Lejeune, 29-Palms, Fort Drum, Quantico, Fort Lewis, Fort Polk, Fort Campbell, and Fort Knox.

A central MOUT issue is situational awareness (SA), or the understanding of the military condition at hand. It includes the ability to quickly and correctly locate and identify hostile forces, own forces, and neutral non-combatants. As urban operations often take place within buildings that may contain any or all of these categories of personnel, MOUT presents particularly difficult situational awareness issues.

B. PURPOSE

This paper is an investigation into the utility of enhanced situational awareness in military operations in urban terrain. It is a continuation of two previous studies that examined the impact of various levels of information for the warfighter in small unit operations [Refs. 1, 2]. It is based upon a series of simulation trials in which two fireteams of dismounted infantry (DI) attempt to wrest control of a building on the McKenna MOUT site from an entrenched hostile force. This investigation was undertaken in order to better understand the way in which enhanced situational awareness could save lives and reduce casualties under conditions in which a relatively small Blue unit is required to enter and secure buildings in counter-insurgency operations.

A second purpose of this paper is to evaluate the Soldier Visualization System (SVS) and Dismounted Infantry Semi-Automated Forces (DISAF) as tools for MOUT-related analyses. Indeed, the underlying experiment was a vehicle for familiarizing the study team with these simulations. Briefly, both are interactive distributed simulations. DISAF enables users to create path networks along which infantry fireteams can walk,

crouch, or crawl, both indoors and outdoors. While moving along these networks, the members of these fireteams can engage members of hostile units (other dismounted infantry in this case), change posture, or alter their routes and seek protective cover. Engagement behavior is automatic, whereas the user makes posture and route selections. DISAF provides a two-dimensional "top" view (commonly known as "third person") of the terrain, buildings, and entities.

SVS simulates the detailed kinematics of individual dismounted infantrymen. Each SVS entity is controlled by a player who uses a joy-stick to impart translational motion, alter posture, and fire weaponry. Unlike DISAF, SVS infantrymen do not automatically engage opponents——but are dependent on the user to aim and fire simulated small arms associated with the DI. SVS provides the user with a "stealth view" (or "first person" in modern parlance) of the MOUT site and its combatants.

C. TEST PLAN

This experiment consisted of a series of 20 McKenna MOUT site-based trials in which half were conducted with an enhanced level of situational awareness available to the Blue team and half were conducted at nominal levels. Enhanced situational awareness meant, for purposes of this test, that the Blue team had perfect knowledge of its own and the Red force locations. Nominal situational awareness meant that the Blue team knew only its own force location and the position of Red entities detected by the Blue force.

The Blue team operated DISAF and the Red team operated SVS. In a given trial, the Blue team was made up of two members of the study team, each controlling one four-man fireteam, while the Red team consisted of three study team members (each controlling one SVS infantryman). All combinations of two and three member teams from the five available operators played at high and low SA levels during the course of the experiment.

The Red team occupied the first floor[1] of Building A on the McKenna MOUT site. They assumed defensive positions wherever they saw fit. The Blue force approached Building A from behind the outlying McKenna buildings or its various tree

[1] The restriction to the first floor was somewhat unsatisfying as the rooftop is often a preferred defensive position. This restriction was enacted largely to accommodate certain limitations of the models.

lines. The Blue force attempted to enter the building and dislodge Red. The game ended when all the members of one team were disabled.

D. OUTCOMES

The Blue team suffered 18 more casualties, or approximately 2 more per game on average, under low conditions than under enhanced situational awareness (Blue lost a total of 55 personnel in the course of 10 low SA games and 37 in 10 high SA games). Of these, 14 casualties occurred while approaching the building and four occurred inside. Red lost at least two combatants in every game. Blue losses varied between zero and eight. Figure ES-1, in game order by Blue team, summarizes the trial outcomes.

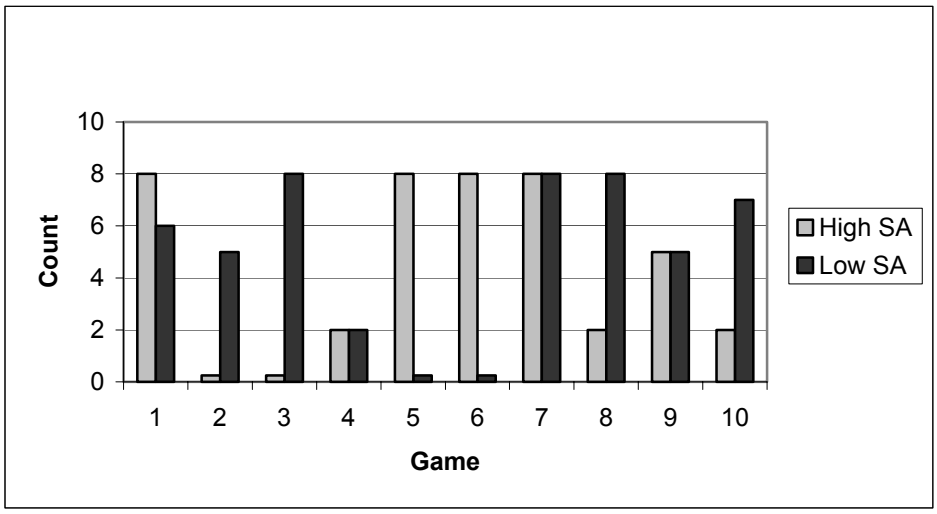

Figure ES-1. Blue Casualties

Figure ES-1 shows that Blue teams suffered fewer casualties in four games in which they had enhanced situational awareness (labeled "High SA" in the chart), than in the corresponding low conditions games, suffered more in three games, and the same number three times (Games 4, 7, and 9). A non-parametric pairwise comparison (Wilcoxon Signed Ranks Test) of these data indicates that the difference in Blue casualties under enhanced and low SA conditions is not significant.

Table ES-1 displays the number of wins and losses over the course of the 20 experimental trials. Blue was victorious in 8 of the 10 games in which it enjoyed

enhanced situational awareness, but split the low games evenly with Red. No games ended in ties.

Table ES–1. Wins and Losses

Blue Team	Test Condition		Total
	Low SA	High SA	
Win	5	8	13
Loss	5	2	7
Total	10	10	20

While these data appear to indicate that SA has a strong effect, they are insufficient to reject the null hypothesis that wins and losses are independent of test condition (the Fisher-Irwin Exact Test is not significant). Indeed, under the null hypothesis, the expected number of Blue wins in "High SA" is 6.5 and the expected number of losses is 3.5. A larger set of trials may have resulted in more definitive outcomes.

E. TACTICAL ANALYSIS

We conducted an examination of Blue tactics to determine the reason Blue odds of surviving increased with enhanced situational awareness. Each trial was reviewed from datalogger files and we analyzed the behavior of Blue forces with respect to unit coherence and coordination with which missions were executed. In the course of reviewing these files, a striking difference between the enhanced and normal games became apparent. During the low SA games, Blue tended to make use of "scouts," small one or two-man patrols that would approach Building A with the intent of locating the Red combatants. These scouts tended to become casualties. Indeed, 18 Blue casualties were associated with this scouting mission (14 while approaching the building, 4 while inside).

On the other hand, when Blue enjoyed full visibility (that is, enhanced situational awareness), it tended to reach the building safely. Under these conditions, Blue attacked the various rooms in a synchronized manner, often engaging a target from two directions simultaneously—or nearly so. When it was not possible to execute this pincer maneuver, Blue would attempt to "rush" Red combatants with several fireteam members. In low SA games, once it learned the Red locations, Blue's tactics became much the same as in the

enhanced SA trials. It exercised its missions with the same unit cohesion and suffered casualties at no greater rate than under the more favorable conditions.

F. CONCLUSIONS

1. Models

a. DISAF

The operator's ability to exercise fine control and to react to changes was found to be very limited using DISAF. In previous studies [Refs. 1, 2] of tank battles using Modular Semi-Automated Forces (ModSAF), a "MOVE" command (to a specific point on the map display, selected by a mouse click) was commonly used to quickly direct tanks and override any previous commands. This command did not function properly for individual soldiers (or, at least, the study team was unable to make it work). In these experiments, operators constructed paths and submitted combat instructions for the soldiers to follow these paths. This process was cumbersome and commands were not easily changed or overridden.

DISAF has a few complex behaviors, but these were not found to be useful. For example, there is a "CLEAR ROOM" command that was not used. More generally, each operator elected not to use commands to the entire fire team[2] and instead elected to control each member individually. This was more cumbersome and time consuming but was the only way to achieve coordination adapted to the situation. Even so, coordination was difficult. Other than the room clearing order, there were no commands that directed soldiers to act together, e.g., to move or to attack when another soldier reaches a certain position.

Some tactics that would have been logical to try to use were not because DISAF did not have the tools. Perhaps the best example of this is the inability to use protected or semi-protected positions. It was not possible to quickly peer around corners or to find a partly protected location to fire from (this severely limits the model's realism).

In summary, DISAF does not seem well adapted to the rapid, precise, and dynamic movements and decisions that might be required in a MOUT environment. For

---

[2] The number of combatants controlled differed depending on whether one operated DISAF or SVS. While this may have introduced a disparity in workload, it did not affect the measurement of the impact of the test variable situational awareness.

these experiments, the DISAF operators constructed planned maneuvers, which worked reasonably well when enemy locations were known and the enemy soldiers were not moving.

b. SVS

This experiment revealed significant SVS limitations. Probably the greatest is "awareness." The single computer screen does show much peripheral vision, and it is not possible to move the soldier's head (separately from his body) to look around. The controls are somewhat "jumpy," so that controlling fine motion and aiming at small targets can be difficult.

In addition, simulation implementation problems exist. Soldiers can become "stuck" in walls if they move too close to them, and may even protrude through the other side (where they are vulnerable). During these exercises, SVS would freeze occasionally for a few seconds, apparently when network traffic was heavy.

In summary, SVS is much better than DISAF in responding to individual control but nonetheless has limitations that affect the user's ability to conduct (moderately realistic) simulated MOUT operations.

2. Situational Awareness

The limitations of the simulators and the use of a single limited scenario precludes drawing general conclusions about how to conduct MOUT operations or the absolute value of awareness of enemy positions. Instead, this small experiment suggests ideas that might be analyzed more thoroughly, including:

- Tactics might vary depending on situational awareness, and more effective tactics might be used with greater situational awareness.
- The unprotected approach to a defended building is highly dangerous and might benefit greatly from awareness of enemy locations within the building. (It should be noted that in these experiments the defending force did not have sufficient manpower to cover all possible approach paths.)

In these experiments, the Blue force used much better coordinated attacks when the Red positions were known than when they were not. When the positions were not known, Blue actions tended to be exploratory and frequently resulted in one or more scout soldiers getting killed. When positions were known, Blue seldom used only one soldier to attack an enemy position.

The difference in tactics was most notable in approaching the building. If positions were known, Blue would generally approach the building from an unobserved direction and mount a coordinated attack after reaching the building perimeter. If enemy positions were not known, Blue would most often send soldiers individually to approach the building, until a safe approach path was found.

These experiments did not resolve questions involving tactics and effectiveness within the building. In particular, Blue losses in approaching the building without situational awareness might have occurred within the building (in discovering enemy positions), even if the force was able to approach without losses. Thus no accurate and unbiased measurement was taken of Blue's vulnerability without situational awareness within the building.

(This page is intentionally blank.)

I. BACKGROUND AND INTRODUCTION

A. PURPOSE

This paper is an investigation into the utility of enhanced situational awareness in military operations in urban terrain. It is based upon a series of simulation runs in which two fireteams of dismounted infantry (DI) attempt to wrest control of a building on the McKenna MOUT site from an entrenched hostile force. This investigation was undertaken to better understand the way in which enhanced situational awareness could save lives and reduce casualties under conditions in which a relatively small Blue unit is required to enter and secure buildings in counter-insurgency operations.

A secondary purpose of this paper is to evaluate the Soldier Visualization System (SVS) and Dismounted Infantry Semi-Automated Forces (DISAF) as tools for MOUT-related analyses.

B. MCKENNA MOUT SITE

The McKenna Military Operations in Urban Terrain (MOUT) site in Fort Benning Georgia, is a practice ground for Military Operations in Built-up Areas (MOBA). As a result of a Defense Science Board (DSB) study in 1994, the Army's Topographic and Engineering Center (TEC) in Fort Belvoir, Virginia, created a digital terrain database of the MOUT site that could be used in simulations. This database uses a higher resolution than is common for these sorts of databases. The results of the MOBA Terrain Database project are posted on the web at http://www.tmpo.nima.mil/news/moba.html.

We selected this terrain for the experiment for several rasons: (1) it was the only synthetic terrain available over a real practice MOUT site in the IDA Simulation Center; (2) it had sufficient number of and detail in and buildings to create interesting and insightful scenarios; (3) versions of this terrain, compatible with both the SVS and Dismounted Infantry Semi-Automated Forces (ModSAF), were available.

C. SVS AND DISAF

As suggested in the previously, we performed this study using two interactive simulations, SVS and DISAF, which we selected largely on the basis of supporting a representation of the McKenna MOUT site's terrain. More specifically, each simulation allows the user to conduct free play engagements in and around certain of the McKenna buildings.

DISAF enables users to create path networks along which infantry fireteams can walk, crouch, or crawl both indoors and outdoors. While moving along these networks, fireteam members can engage hostile units (other dismounted infantry in this case), change posture, or alter their routes and seek protective cover. Engagement behavior is automatic, whereas the user chooses posture and routes.

DISAF provides a two-dimensional view of the MOUT site, showing the buildings' interior rooms and, depending on test conditions, locations of combatants. A sample image of the site, showing the interior of Building 10, appears in Figure 1.

SVS simulates the detailed kinematics of individual dismounted infantrymen. Each SVS entity is controlled by a player who uses a joy-stick to impart translational motion, alter posture, and fire weaponry. Unlike DISAF, SVS infantrymen do not automatically engage opponents but are dependent on the user to aim and fire simulated small arms associated with the DI. SVS provides the user with a "stealth view" of the MOUT site and its combatants. That is, unlike the two-dimensional DISAF view, the SVS user can see the battleground from the perspective of the entity being controlled. This is a much more local but ever-changing view of buildings, vegetation, and people.

The analysis team was familiar with DISAF from work on previous studies. While less than enthusiastic about DISAF capabilities, the team believed this simulation could provide the basic functions necessary to address the core issues in this MOUT analysis. On the other hand, the analysis team wanted to find new models with which to conduct studies of this type. Because SVS was available on a number of Simulation Center workstations, it became a candidate simulation for this task. After a certain amount of "pilot testing," the analysis team determined that SVS and DISAF were compatible in the sense that they interacted in a tractable manner and yielded what appeared to be credible results when used together in simple MOUT scenarios.

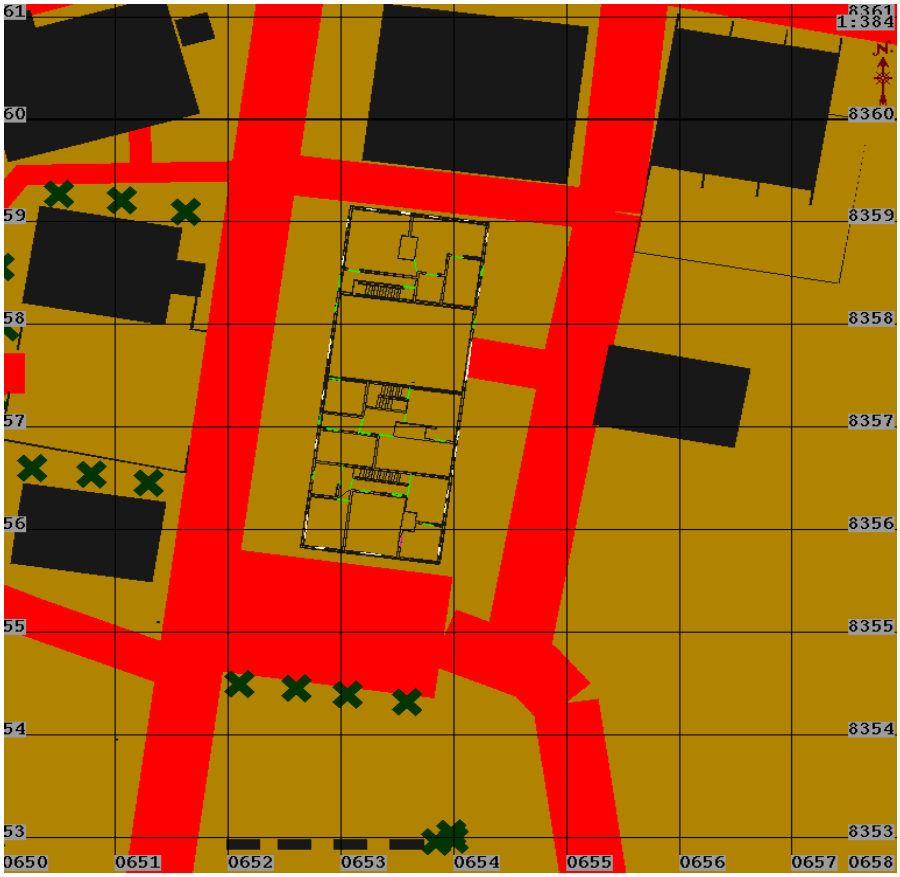

Figure 1. Building Interior at the McKenna MOUT Site

D. SITUATIONAL AWARENESS: VISIBILITY AS PROXY

The primary purpose of this task was to measure the effect of enhanced situational awareness on urban operations. To perform these measurements, it was necessary to define—in terms of the simulations at hand—the notion of "enhanced situational awareness." The simplest candidate notion involved the condition in which all combatants were continuously aware of the locations of all other combatants in the engagement at hand.

This definition was particularly appealing because it was both an upper limit on what one could expect to know in a battlefield engagement, and it was reasonably simple to implement using the DISAF simulation. Also, it provided a reasonable alternative against which it could be compared. More precisely, DISAF provides a menu-driven toggle that allows players to switch between two extreme viewing capabilities. The first

allows players to see all combatants, but the second permits players to see only own-side entities (and those within line-of-sight).

Because no similar notion applies to SVS (which provides a line-of-sight capability but has no two-dimensional top view like DISAF), we decided to use DISAF as the Blue counter-insurgency team. We conducted two sets of trials: one in which Blue had the ability to see all combatants, and one in which Blue could only see its own side.

II. GAME SETUP AND EXECUTION

A. FACILITY AND TEAMS

All trials were conducted in the IDA Simulation Center. This facility houses three SVS workstations and more than a half dozen Silicon Graphics workstations (DISAF hosts). Each SVS workstation requires one operator/player and simulates one dismounted infantryman. The DISAF workstations also require one operator but are capable of simulating large numbers of four-man fireteams or nine-man infantry squads. Since five players were on the analysis team, the availability of equipment determined the composition of the insurgency (Red SVS) and counter-insurgency (Blue DISAF) forces. The SVS insurgency team would consist of three combatants (controlled by three operators) and DISAF counter-insurgency team would be made up of two four-man fireteams (controlled by two operators).

To conduct a balanced experiment, all 10 possible combinations of three versus two-player squads were formed from the five available players. Players were designated by the letters "a" through "e," and teams were designated by concatenating the letters of their members.

B. TRIAL MATRIX

A total of 20 trials were conducted: 10 with enhanced situational awareness (or "high visibility" as described in Chapter I, Section C) on the Blue/DISAF side and 10 with standard situational awareness. Recall, under standard situational awareness ("low visibility"), each player sees only the members of his own team and the opponents within line-of-sight of entities under his control. Twenty trials permitted each team to play once under each SA condition.

Table 1 summarizes the schedule of games. The 10 groups of players were placed in random order. Within this ordering, each team played two games: one at each of the SA levels. The Blue DISAF team selected the SA they wanted to play first and withheld this choice from their SVS opponents until both games were completed. Of course, the subsequent game was conducted at the opposite level. The "within-team" ordering is

shown in the third column where the first of a pair is shown at the left boundary of the column and the second is shown on the right.

Table 1. Trial Matrix

Trial	Date	Blue-Red Teams	SA Level
1	5/18/00	CD - ABE	high
2	5/18/00	CD - ABE	low
3	5/18/00	AB - CDE	low
4	5/18/00	AB - CDE	high
5	5/26/00	BD - ACE	high
6	5/26/00	BD - ACE	low
7	5/26/00	AE - BCD	high
8	5/26/00	AE - BCD	low
9	6/14/00	BC - ADE	low
10	6/14/00	BC - ADE	high
11	6/19/00	CE - ABD	low
12	6/19/00	CE - ABD	high
13	6/19/00	AD - BCE	high
14	6/19/00	AD - BCE	low
15	6/23/00	DE - ABC	high
16	6/23/00	DE - ABC	low
17	6/23/00	AC - BDE	low
18	6/23/00	AC - BDE	high
19	7/28/00	BE - ACD	low
20	7/28/00	BE - ACD	high

Half of the enhanced SA games were played first and half of the low SA games were played first. This was fortuitous in that it provided a convenient means of testing whether or not order (within a team's pair of games) affected outcomes. This balance was not pre-preordained, however, as will be discussed in Chapter II, Section C

Typically two or four games were played in one session (day). Each game required approximately 20 minutes to complete.

C. CONDUCT OF THE GAMES

The next few paragraphs are a short description of the manner in which the games were played. Ground rules, player interaction and coordination, and a number of other factors that dictated game conduct are related in detail. This section is intended to

provide the reader with some background and insight so the remainder of the paper can be read in the proper context.

Each game was a contest between two teams of players controlling entities representing opposing sides in a localized urban combat scenario. All games were played in and around a single building that was occupied by three Red SVS infantrymen (controlled by three operators). Two Blue DISAF four-man fireteams (controlled by two operators) attempted to dislodge them. Games were played until all members of one team became casualties.

The Red and Blue operators were located in separate rooms. Communication between the rooms (to synchronize the start of trials, etc.) was over the local area network or the phone. In this way, discussions concerning coordinated tactics and test condition would not be heard by the opposing team.

At the start of a trial, each side would enter its area, activate its simulation software, and discuss battle plans. When ready to begin, each side would signal the other (usually by phone). When both teams were prepared, the Blue team would begin the "datalogger,"[1] and the battle would begin. From this point on, games were "free play" in the sense that there were no prescribed scripts to follow and each player was permitted to control his combatants as he saw fit. However, some ground rules were applied to "level the playing field" between the two simulations; others pertained to the information available to each side regarding the test conditions. These rules and other factors influencing the trials are discussed in the next few sections.

1. General Rules

The two simulations, SVS and DISAF, differ in a number of critical respects. SVS is much more dependent on human intervention, while DISAF has a great deal of autonomous behavior. Not all characteristics favored DISAF however. For example, SVS entities had greater capacity for ascending stairs (Building A has two stories), and, in certain cases, could move through walls. To conduct a trial in a reasonable manner, certain rules were imposed to compensate for model differences. Other rules were imposed, not because of model advantages, but simply to limit the scope and duration of the engagements.

---

[1] The "datalogger" software records protocol data units broadcast by the simulations.

Ground rules prohibited the following Red (SVS) activities:

- Entering the second floor
- Leaving the building, except to change rooms
- Moving through walls.

The first rule was imposed because of a limitation in DISAF that made the transition to the second floor difficult to execute. Thus, this rule eliminated what was perceived as an unfair advantage for Red. The second rule was enforced to contain the activity. Only one building on the McKenna site is modeled with a complete interior (Building A), so engagements were restricted to that building in order to retain the MOUT character of the experiment. Also, allowing outdoor activity would likely prolong the length of the individual trials. The third rule was imposed because SVS has the ability to move from room to room without the benefit of a doorway, whereas DISAF does not.

The following rules were imposed on Blue (DISAF):

- DI perform at the novice level.
- Engagement range is restricted to 15 meters or less.
- Casualties are removed from the "playing field"

Performance was restricted to the novice level because preliminary testing indicated DISAF's normal reaction time is quicker than the human operator's. This gave DISAF an apparent advantage in otherwise even tactical situations. Range limitation was enforced for much the same reason: DISAF is capable of shooting accurately at ranges well over a kilometer, while the SVS operator has a much more limited capability. Casualties were removed because of a peculiar DISAF/ModSAF feature that allows entities that have suffered catastrophic kills to "report" the location of enemy units. More precisely, an entity is displayed on a Plan View Display (PVD—the graphical interface for the workstation hosting DISAF) when an object belonging to the local force (as defined by the PVD) is within line-of-sight and has the proper orientation. This function is not curtailed when the local force object has been destroyed or killed. To prevent Blue from capitalizing on this feature, dismounted infantry were removed from the game once they were killed.

2. Secrecy of Visibility Level

In addition to those listed above, an additional rule related to test conditions was imposed on the players. As discussed previously, two SA conditions were examined in these trials. Each team played back-to-back games, one at high SA (visibility) and one at low SA (although the order in which teams played was randomized). The Red team did not know which condition held until after both games of a trial pair were complete. This information was withheld because it was believed Red might change tactics and, in some manner, confound the test conditions. (A favorite pastime for the Red SVS players was guessing whether Blue had visibility during the first or second trial of a session.)

3. Technical Difficulties

One aspect of simulation trials that colors the manner in which experiments are conducted is the ease with which players interact with the software. In this test, technical difficulties were encountered, but all were manageable, and none caused any sessions to be aborted or tests to be rerun (a small number of games were restarted, however). In particular, the DISAF stations would sometimes crash and their entities would be lost. When this happened, the operators would recover as necessary. The logger would not be stopped or paused. As the operators gained experience and proficiency with the equipment, the frequency of DISAF crashes diminished.

On several occasions, the SVS entities became stuck in the walls while attempting to navigate through the rooms of Building A. This is a shortcoming of SVS that allows DI to penetrate walls while traversing narrow passageways or hunkering in stairwells. Sometimes this caused the DI to get stuck in the wall. Occasionally this resulted in a DI being shot because he was partially exposed on the opposite side of a wall he intended to hide behind. This problem could generally be resolved by pressing the "go through wall" button on the joystick.

These—and the occasional temporary system “freezes”—were the foibles of the game. Beyond these, few problems occurred and the sessions generally ran smoothly to completion.

(This page is intentionally blank.)

III. OUTCOMES OF THE TRIALS

A. CASUALTIES

1. By Visibility Condition

The objective of the simulation trials was to test the (null) hypothesis that enhanced situational awareness has no effect on Blue performance. We measured Blue's performance by the number of casualties suffered and the number of missions successfully completed (we defined mission success as defeating all members of the Red insurgency force). Traditional measures, such as exchange ratios, were shunned because of the small size of the Red force: small variations in Red casualties could produce large percentage changes in the ratio of, say, Blue to Red losses. Also, in the current spirit of peace-keeping missions, minimizing Blue casualties is likely to be considered more important than the relative rates at which friendly and hostile forces are diminished.

Table 2 displays the number of Blue casualties and survivors for the two test conditions. Over the course of these trials, Blue suffered 18 more casualties while under low visibility than under the enhanced SA. Table 2 indicates that, under the low condition, the probability of a Blue DI surviving the MOUT mission was only about 32 percent. Under the higher condition, survival probability was about 54 percent. A Chi-Squared[1] test applied to these casualty data indicates that the difference in the odds of survival under the two conditions is significant below the 1-percent level.

It is interesting to note however, that a non-parametric paired comparison (Wilcoxon Signed Ranks Test) of casualties *failed to show* a significant difference between the high and low visibility trials. These data, paired on a team-by-team basis, are displayed in Figure 2. Although this may be paradoxical, it is not a contradiction of the results from the Chi-Squared tests because the former concerns the relative odds under two test conditions, and the latter focuses only on the number of casualties.

---

1 This may appear to be a cavalier use of the Chi-Squared test as the sampling unit was the trial and not the dismounted infantry. However, the perceived difficulty goes away because all trials contained the same number of DI.

Table 2. Blue DISAF Casualties by SA/Visibility Condition

Mortality	Test Condition		Total
	Low VIS	High VIS	
Dead	55	37	92
Live	25	43	68
Total	80	80	160

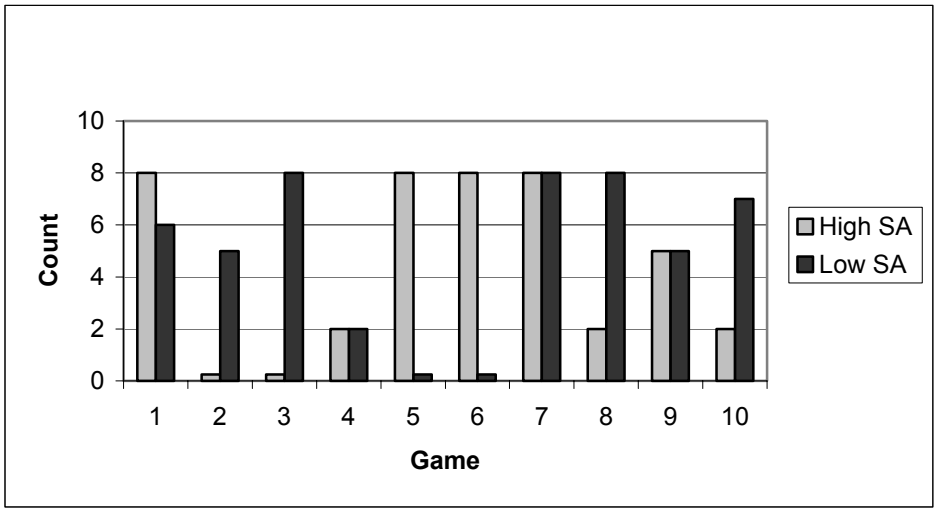

Figure 2. Blue DISAF Casualties: High vs. Low Visibility

Although the Blue casualties are the principal focus, the number of Red insurgent casualties is presented for completeness in Table 3. Typically these varied between two and three for each game and showed little variation over the course of the trials. Statistical tests indicated no dependence of Red outcomes on test conditions.

Table 3. Red SVS Casualties by SA/Visibility Condition

Mortality	Test Condition		Total
	Low VIS	High VIS	
Dead	25	28	53
Live	5	2	7
Total	30	30	60

2. By Game Order

Figure 2 shows the number of Blue casualties by game order. While no obvious significance appears in the overall order of play, a number of observations can be made from the figure. First, three of the Blue teams suffered more casualties in their first game than in their second, and four teams suffered more in the second. Three teams showed no difference. Also, three teams did worse with visibility than they did without and four teams performed better. Three teams performed equally. Of the four teams showing improvement with visibility, two had visibility in their first game and two had it in their second. Of the three that did worse, two had visibility in their second game.

The probability of Blue DI surviving the first game were somewhat higher in the first game of a team pair than in the second (0.46 compared to 0.39). However, Chi-Squared tests failed to indicate any significant dependence of odds of survival on game order within pairs. Indeed, as Table 4 demonstrates, there were only marginal differences between the number of casualties (or survivors) in the first and second games. Unsurprisingly, the same non-parametric paired comparison, applied above with respect to visibility conditions, also failed to reveal any distinction based on order.

Table 4. Blue DISAF Casualties by Game Order

Mortality	Game Order		Total
	First	Second	
Dead	43	49	92
Live	37	31	68
Total	80	80	160

3. By Team

For completeness, Red team outcomes are presented by order within team pairs in Table 5. Outcomes for Red show no significant differences in Red survival odds as a result of order.

A non-parametric test (Friedman Test for multiple related samples) did not reveal any significant differences among the 10 Blue teams. However, this test produced a ranking of the teams based on the number of casualties in two trials, which appears in Table 6 (lowest ranking is best). Also, an analysis of variance (ANOVA) showed no strong team effects or interactions among team players in these trials.

Table 5. Red SVS Casualties by Game Order

Mortality	Game Order		Total
	First	Second	
Dead	26	27	53
Live	4	3	7
Total	30	30	60

* Not significant

Table 6. Team Rankings

Team	ae	ab	bc	bd	ce	ac	be	de	cd	ad
Rank	3.5	3.75	5	5	5	5.25	5.25	6.25	7.25	8.75

B. WINS AND LOSSES

1. By SA/Visibility Condition

For purposes of these trials, a successful mission from the Blue perspective was one in which all Red combatants were defeated. All others were considered victories for the insurgents. Blue won the overwhelming majority of games with enhanced SA. Indeed, Blue won 8 out of 10 of these trials. On the other hand, the low visibility games were split equally, with five won by Red and five won by Blue (see Table 7). Thus visibility appears to be a strong influence on outcome.

Table 7. Wins and Losses by SA/Visibility Condition

Mortality	Test Condition		Total
	Low VIS	High VIS	
Blue Win	5	8	13
Blue Loss	5	2	7
Total	10	10	20

From a technical perspective, however, this conclusion is optimistic. For example, the two-sided Fisher Exact Test indicates that outcomes at least this extreme occur in about one-third of the cases. While this may appear counter-intuitive, it is important to keep in mind that what is being examined here is not whether the probability of winning is 0.50, but rather, whether or not visibility makes a difference. One helpful insight into this issue is to observe that the maximum likelihood estimate of probability of

Blue loss is 0.35 under the (null) hypothesis that no difference exists between test conditions. With this probability, outcomes as extreme[2] as those in Table 7 occur about 13 percent of the time.

2. By Game Order

Similarly, the order in which games were played did not have a great impact on the odds of winning. Table 8, which gives the total wins and losses by order within team pair, shows that relative odds vary between 1.5 in the first game to 2.3 in the second. However, due to small sample sizes, this difference is not significant.

Table 8. Blue Wins and Losses by Game Order

Outcome	Game Order		Total
	First	Second	
Blue Win	6	7	13
Blue Loss	4	3	7
Total	10	10	20

3. By Team

Outcomes varied somewhat by team, but since each team (Red or Blue) played together for only two games, it is difficult to draw very strong conclusions from these results. Indeed, four Blue teams won both their games. One Blue team lost both. The five remaining teams split their games evenly. One player ("a") served on three of the four winning Blue teams, but also played with the team that lost both games (but no teams with split records). Two players ("b" and "e") served on two winning teams and also on two teams with split records, but no losing teams.

Teams were ranked using a non-parametric (Friedman) test for multiple related samples. Rankings varied from a high of 7.25 for "ab," "ac," "ae," and "be" to a low of 2.25 for "ad." All other teams received a 4.75 ranking (the highest rank is best). Despite the range of these ranks, the test failed to find significant differences among the 10 teams.

Table 9 presents the number of wins by each Blue team (labeled by the players on the team). Of course, the same table can be interpreted as a description of the Red

2 Extreme in the sense that one group loses no more than two while the other loses at least five.

defensive teams as well. Table 10 shows the number of winning games recorded by each player. Each played eight games as Blue and twelve games as Red.

Table 9. Blue Team Totals (Wins and Losses)

Outcome	Team									
	ab	ac	ad	ae	bc	bd	be	cd	ce	de
Wins	2	2	0	2	1*	1*	2	1	1*	1*
Losses	0	0	2	0	1	1	0	1	1	1

* The single win occurred under enhanced SA (high visibility)

Table 10. Player Totals (Blue and Red Wins)

Outcome	Player				
	a	b	c	d	e
Blue wins	6	6	5	3	6
Red wins	5	5	4	2	5
Total	11	11	9	5	11

IV. ANALYSIS OF TACTICS

A. VISIBILITY LEVEL

After all the exercises were completed, we reviewed the logger files in an attempt to isolate those tactics that were different under low situational awareness exercises from those used under enhanced or high SA exercises. Since the Red forces were unaware of the visibility level, their tactics were assumed to be the same under both conditions.

Review of the tactics used by the Blue force revealed an interesting and obvious difference between high SA tactics and low SA tactics.

Under high SA conditions, the Blue force tended to attack Red forces using coordinated attacks. In few cases were less than two Blue DI deployed in an initial attack on a Red objective. Figure 3 shows an example of a coordinated attack by Blue forces on a Red position in a high SA exercise. Notice that Blue forces have surrounded the Red stronghold at the entrance to the staircase. In this particular instance, Blue assaults the Red position with two units advancing simultaneously in a staggered formation. In the attack, Blue was successful in annihilating the Red position while losing one unit.

On the other hand, under low SA conditions, the overwhelming initial tactic that Blue forces used was to send certain “lone-scouts” to discover what positions were being held by Red forces. After discovering Red positions, Blue's tactics proceeded the same as under high SA situations (Blue assumed Red positions would not change, so they proceeded as if they knew all Red positions for the remainder of the game). Figure 4 shows an example of the use of the “lone-scout” tactic in a low SA exercise. Since Blue does not know the location of Red forces, it sends units to discover the positions being held by Red. The two Blue units located at the northern windows are there obviously to see if the respective rooms are occupied. Notice that each room is being monitored by a single Blue unit compared to the massed convergence of Blue units as seen in Figure 3. The single Blue unit labeled “SCOUT” in Figure 4 is shown shot on approach to the building by a Red unit looking out of a window to the south. The line that traces between the Red unit to the south and the Blue scout is the actual projectile path as shown on the DISAF station when the shot was fired. Since the DISAF station shows the trajectory of

the shot, it becomes a simple deduction for Blue to determine the Red position once a shot was fired. In contrast, under high SA condition, Blue rarely gets killed on approach to the building since the approach routes will be chosen to reduce his vulnerability. A few seconds after this particular screen-capture was taken, the Blue unit to the northeast was killed by the Red unit hiding inside the small closet when the Red moved up to get line-of-sight to that window—another scout casualty.

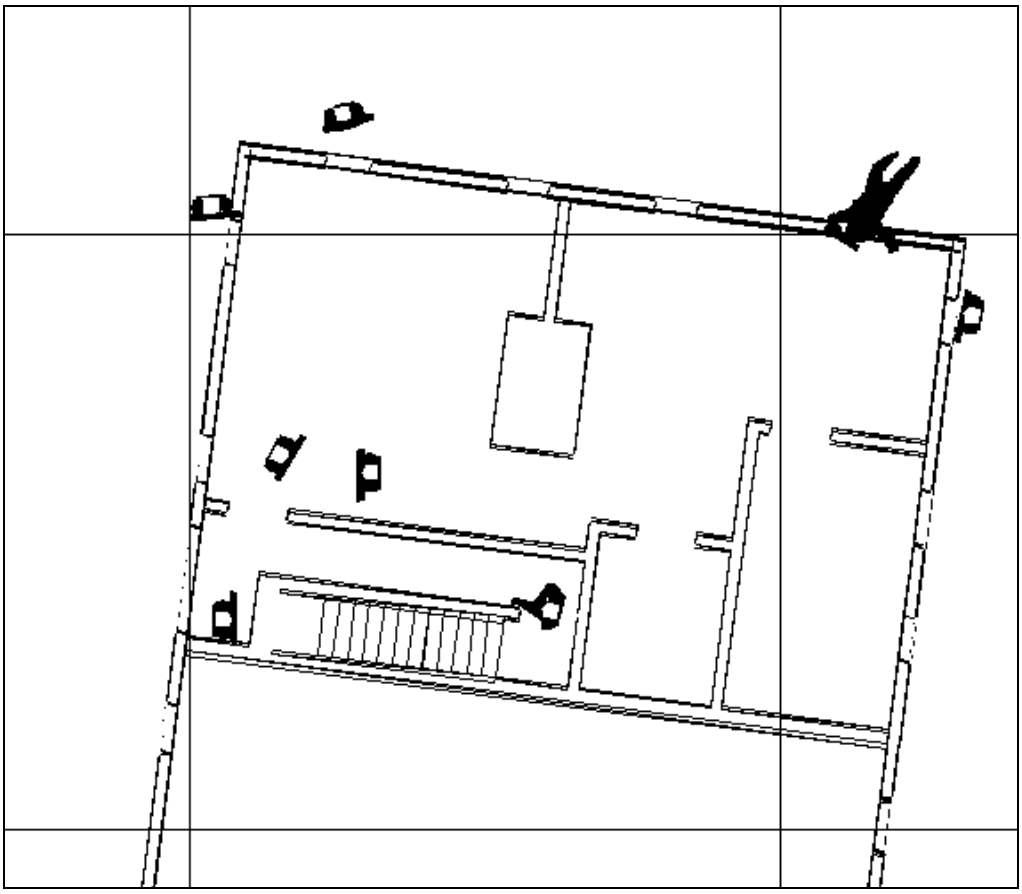

Figure 3. Example of Coordinated Assault

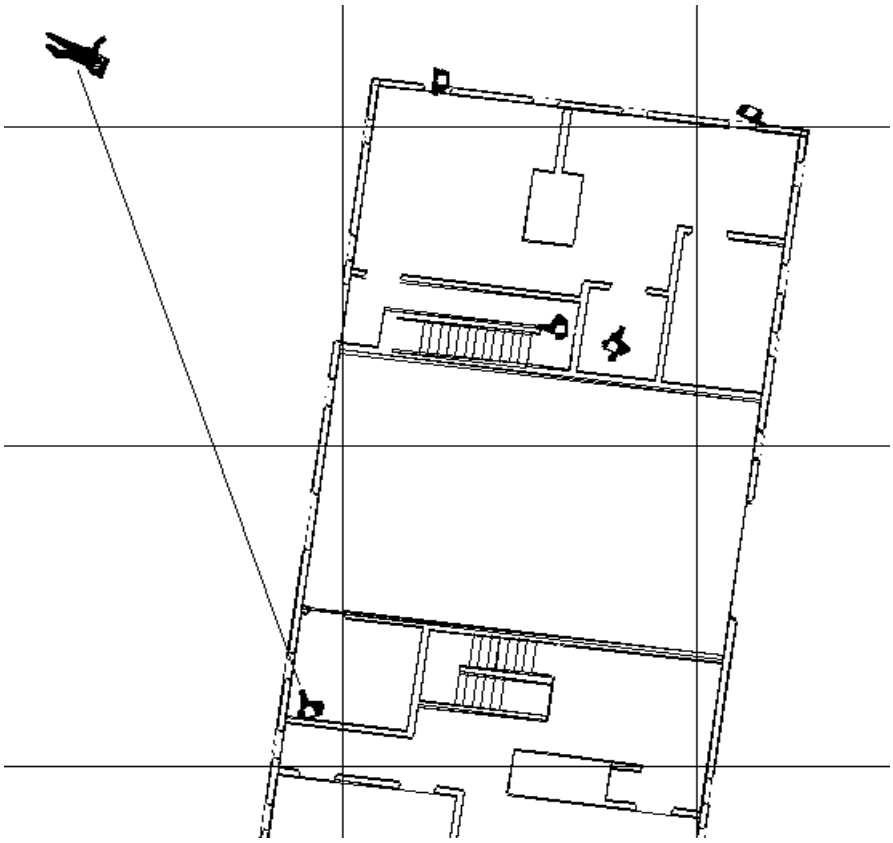

Figure 4. Example of the "Lone-Scout" Tactic Used In Low Visibility Exercises

Given the above observations, we speculated the following: Blue tactics under low SA and high SA are the same, after an "initial cost" has been incurred by Blue under low SA to locate Red positions.

In an attempt to quantify our speculation, we set out to tabulate the total number of Blue forces that were lost as part of the initial cost expended by Blue forces to identify Red positions. If indeed the initial cost was the only difference in tactics under high and low SA conditions, the overall initial cost sum should be close to 18 (recall from Chapter III that Blue forces suffered 18 more losses under low visibility situations than they did under high SA situations).

To tabulate the initial cost Blue forces suffered under low SA conditions, we replayed all logger files for low SA games and counted all Blue forces lost to Red

positions that were unknown to Blue at the time. Red positions became known when a Blue unit had either line-of-sight to the Red unit or when the Red unit fired his weapon. Red units could also occupy multiple unknown positions if they moved into a new position without being observed by Blue forces. Indeed, a single Red unit scored multiple Blue scout kills in several trials as a result of successful movement.

The total initial cost Blue forces suffered during the low SA exercises is shown in Table 11. Total Blue casualties resulting from unknown Red positions for the 10 low SA games was found to be 18. This is exactly the difference in Blue casualties between the low SA and high SA games. This fact lends credence to our speculation that the only difference in tactics under high SA and low SA exercises was the "scouting out" of Red positions by Blue scouts in low SA exercises. Moreover, 14 Blue scouts were killed outside of the building held by Red, which indicates that the approach was particularly dangerous in the low SA exercises.

Table 11. Blue Casualties Due to Unknown Red Positions in Low SA Games

Low VIS Trials	Blue Casualties Due to Unknown Red Positions
Game 01	2
Game 02	0
Game 03	2
Game 04	0
Game 05	6
Game 06	1
Game 07	1
Game 08	3
Game 094	2
Game 10	1
Total	18

The hypothesis that Blue suffers an "initial cost" in order to locate Red positions under a low visibility condition may be tested with the proposed game matrix shown in Table 12. Blocks 1 and 2 represent the same conditions outlined in this report. Blocks 3 and 4 introduce two additional units on the Blue side. Since Blue forces suffered 18 additional losses in the 10 low SA games, or 1.8 additional losses per game, the two additional units proposed for Blue in blocks 3 and 4 are meant to equalize the outcome in

terms of the number of Blue wins. Additionally, by comparing block 1 to block 3 and block 2 to block 4, we can identify the effect of an increase of 25 percent in Blue forces.

Table 12. Proposed Game Matrix To Test the "Lone-Scout" Hypothesis

Block	Visibility Level	Blue Units
1	High	8
2	Low	8
3	High	10
4	Low	10

B. EFFECT OF RED POSITIONS

From our experience during the game trials and the subsequent review of the logger playbacks, we noticed that some positions in the building were occupied more frequently by insurgency forces. Clearly, these positions were perceived to favor Red. Several factors are involved in these choices, including: defensive and offensive capabilities, possibility of cooperation with other Red players, player personality, previous experience at the same location, etc. Therefore, during our review of logger playbacks, the positions held by Red and the number of Blue kills achieved by each location were carefully recorded in order to determine whether any bias existed between the high visibility and low SA trials as a result of the positions held.

Figure 5 shows the layout of the building that insurgency forces occupy. The basic layout contains four large rectangular sections, which roughly correspond to "Cooperation Zones," indicated as A through D. The individual rooms within each zone are connected, allowing Red players within the same zone to move about and cover each other. The individual location held by Red is identified by a numerical suffix to the zone. Note that in the room that containing position B3, located within the third large rectangular section from the top, actually belongs to zone B since it is only connected to the large, open room to the north.

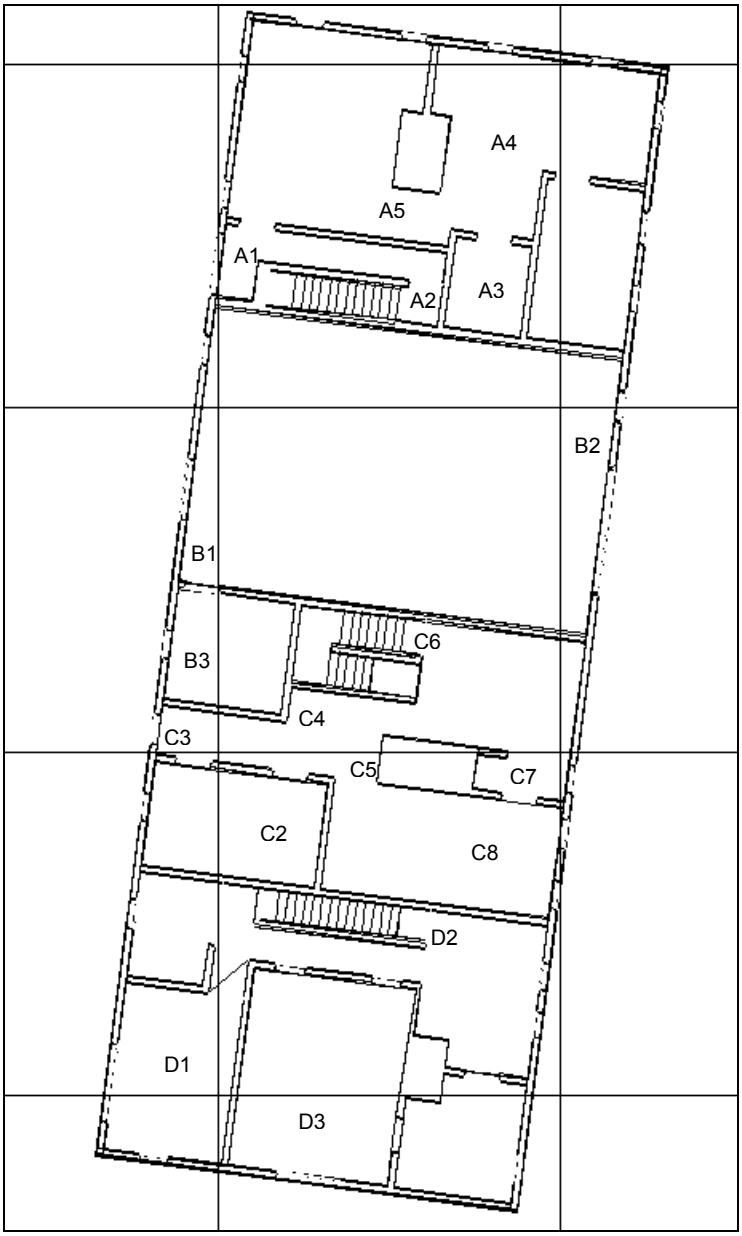

Figure 5. Codes Assigned To Various Positions Within the Building

The location dependent results are tabulated in Tables 13 and 14. "Frequency of Occupation" counts the instances of Red units holding each position. "Blue Casualties" counts the number of Blue units killed from each position occupied by Red. The casualty figure for the scout and non-scout kills are reported separately for the low SA exercises. In addition to the raw data on locations and casualties, two measures of performance are

listed in Table 13: "Percentage of Games Occupied" and "Efficiency Ratio." First, "Percentage of Games Occupied" is derived by taking the total number of occupations for each location for both high visibility and low SA and dividing it by the total number of trials. It is a measure of how often Red holds a position or the probability that a Red unit will be found at any given location during a trial. Second, "Efficiency Ratio" is derived by taking the ratio of the total number of non-scout Blue casualties to the total number of Red occupations for each position. This number could be interpreted as the expected number of Blue kills for each position during a game.

Detail reporting of occupations and kill records for each individual location is shown in Table 13. Comparing the frequency of occupation for positions that are occupied 25 percent of the time or more reveals very little difference between high visibility and low SA. The maximum difference in the number of occupations for these positions—A2, B3, C2, C4, C5, and C6—is only 1. Therefore, the players did not inadvertently favor some positions over others from high visibility to low SA. It can also been seen that four out of six of these highly occupied positions had efficiency ratios of greater than one, while for the less occupied positions, only B1 had an efficiency ratio of greater than one.

Table 14 shows the data in terms of cooperation zones A through D. Clearly, zone C is the most occupied of the four zones. The frequency of occupation and non-scout Blue casualties are comparable for high visibility and low SA in zone C. Zone C also has the highest efficiency ratio of all the zones.

Table 13. Red Frequency of Occupation and Blue Casualties by Position

Red Position	Frequency of Occupation		Blue Casualties		Scout	Percentage of Games Occupied	Efficiency Ratio
	HI-VIS	LOW-VIS	HI-VIS	LOW-VIS	LOW-VIS		
A1		1		0	1	5%	0.00
A2	3	4	2	5	1	35%	0.00
A3	1	3	0	1	3	20%	0.25
A4	1	3	0	3	1	20%	0.75
A5		1		0	1	5%	0.00
A6	1		0			5%	0.00
B1	3	1	6	0	0	20%	1.50
B2	1	1	0	0	1	10%	0.00
B3	3	3	1	0	2	30%	0.17

Table 13. (continued)

Red Position	Frequency of Occupation		Blue Casualties		Scout	Percentage of Games Occupied	Efficiency Ratio
	HI-VIS	LOW-VIS	HI-VIS	LOW-VIS	LOW-VIS		
C1	1	1	0	2	1	10%	1.00
C2	4	3	2	4	1	35%	0.86
C3	1	1	1	0	0	10%	0.50
C4	2	3	6	2	1	25%	1.60
C5	3	2	6	8	0	25%	2.80
C6	4	4	7	11	1	40%	2.25
C7	2	1	2	0	1	15%	0.67
D1	1	1	0	1	2	10%	0.50
D2	3	1	4	0	1	20%	1.00
D3		1		0	0	5%	0.00

Table 14. Red Frequency of Occupation and Blue Casualties by Zone

Red Position	Frequency of Occupation		Blue Casualties		Scout	Efficiency Ratio
	HI-VIS	LOW-VIS	HI-VIS	LOW-VIS	LOW-VIS	
A	6	12	2	9	7	0.61
B	7	5	7	0	3	0.58
C	17	15	24	27	5	1.59
D	4	3	4	1	3	0.71
Total	34	35	37	37	18	

V. CONCLUSIONS

This CRP was the third in a series dealing with situational awareness. The first two were based on small armor engagements. They were conducted using ModSAF alone. This was the first that attempted to integrate a second simulation, the Soldier Visualization station, into a distributed environment along with a ModSAF derivative. Also, this was the first that used (exclusively) dismounted infantry as the experimental entity. The conclusions given here have as much to do with the players opinions of the two models as useful tools for MOUT analyses as they have to do with situational awareness. Indeed, the exercise was largely one that made use of a MOUT scenario, hinged on situational awareness, to evaluate these two models.

A. MODELS

These experiments were conducted with opposing forces using two very different simulators, in addition to having different force sizes, missions, and situational awareness. Each simulator had characteristics and limitations that affected outcomes. For example, DISAF entities reacted to situations much more rapidly than those in SVS. This is largely due to the automated behavior of the former—whereas the latter depend on direct human intervention. Nonetheless, some form of "titration" was exercised in the pilot tests preceding the experiment in order to find a balance between the two simulations. This involved selecting force sizes and capabilities that produced a relatively "level playing field."

1. DISAF

DISAF provides greater flexibility for an operator to control DI units, rather than individual soldiers. For example, fire teams can follow prescribed paths in a coordinated manner and can be instructed to perform relatively sophisticated functions, such as clearing a room. Specific behaviors such as firing or otherwise reacting to the dynamic situation are programmed into the simulation.

The tactical situation is shown on PVD, which is essentially a map with icons showing soldier locations. Depending on the situational awareness level for the

particular run, icons would show all soldiers, or only friendly soldiers and those enemy units in direct sight of a friendly. Control was exercised using familiar computer interface tools such as selecting from a menu of possible commands or designating points on the map with mouse clicks.

The operator's ability to exercise fine control and react to changes was found to be very limited. In previous studies of tank battles using ModSAF a "MOVE" command (to a specific point on the map display, selected by a mouse click as opposed to a combat instruction) was commonly used to quickly direct tanks and override any previous commands. This command did not work for individual soldiers (or, at least, the study team was unable to make it work). In these experiments, operators entered paths and commanded the soldiers to follow the paths. The command process was cumbersome and commands were not easily changed or overridden. This lack of "micro" control proved awkward in MOUT scenarios.

DISAF has a few complex behaviors, but these were not found to be useful. For example, the "CLEAR ROOM" command referred to above was not used. This may have had more to do with the time and patience required to implement the command than its lack of utility. More generally, operators elected not to issue commands to the entire fire team but instead elected to control each member individually. This was more cumbersome and time consuming, but was the only way to achieve coordination adapted to the situation. Even so, coordination was difficult. There were no commands that directed soldiers to act together, e.g., to move or to attack when another soldier reached a certain position.

Some tactics that would have been logical to employ were not because DISAF did not have the tools. Perhaps the best example of this is the inability to use protected or semi-protected positions. Specifically, it was not possible to quickly peer around corners or to find a partly protected location from which to fire.

In summary, DISAF does not seem well adapted to the rapid, precise, and dynamic movements and decisions that might be required in a MOUT environment. For these experiments, the DISAF operators constructed planned maneuvers, which worked reasonable well when enemy locations were known and the enemy soldiers were not moving.

2. SVS

The Soldier Visualization Station is quite different from DISAF: one operator controls one soldier; the controls (a joystick with a trigger, basically) work directly on soldier movement and actions (rather than allowing pre-planned courses of action); and the situation display consists of the soldier's view (rather than a map-like display). This allows dynamic and reactive control that is not possible with DISAF.

There are, however, significant SVS limitations. Probably the greatest is "awareness." The single computer screen does show much peripheral vision, and it is not possible to rotate the soldier's head (separately from his body) to look around. The controls are somewhat "jumpy," so that controlling fine motion and aiming at small targets can be difficult.

In addition, there are simulation implementation problems. Soldiers become "stuck" in walls upon impact and may even protrude through the other side of a wall (where they are vulnerable). During these exercises SVS would freeze occasionally for a few seconds, apparently when network traffic was heavy.

In summary, SVS is much better than DISAF in responding to individual control, but still has limitations.

B. SITUATIONAL AWARENESS

The limitations of the simulators and the use of a single limited scenario precludes drawing general conclusions about how to conduct MOUT operations or the absolute value of awareness of enemy positions. Instead, this small experiment suggests ideas that might be analyzed more thoroughly, including:

- Tactics might vary depending on situational awareness, and more effective tactics might be used with greater situational awareness.
- The unprotected approach to a defended building is highly dangerous, and might benefit greatly from awareness of enemy locations within the building. (It should be noted that in these experiments the defending force did not have sufficient manpower to cover all possible approach paths.)

In these experiments, the Blue force used much better coordinated attacks when the Red positions were known than when they were not. When the positions were not known, Blue actions tended to be exploratory and frequently resulted in one or more

scout soldiers getting killed. When positions were known, Blue seldom used only one soldier to attack an enemy position.

The difference in tactics was most notable in approaching the building. If positions were known, Blue would generally approach the building from an unobserved direction and mount a coordinated attack after reaching the building perimeter. If enemy positions were not known, Blue would most often send soldiers individually to approach the building until a safe approach path was found.

These experiments did not resolve questions involving tactics and effectiveness within the building. In particular, Blue losses in approaching the building without situational awareness might have occurred within the building (in discovering enemy positions), even if the force was able to approach without losses.

REFERENCES

1. DeRiggi, Carpenter, Lin, Stone, Wong, *Distributed Simulation Based C2 Experiments*, D-2194, September, 1998
2. DeRiggi, Carpenter, Lin, Stone, Wong, *Distributed Simulation Based Situational Awareness Experiments*, D-2409, December 1999

(This page is intentionally blank.)

Appendix A
DISTRIBUTION LIST FOR IDA DOCUMENT D-2508

Appendix A
DISTRIBUTION LIST FOR IDA DOCUMENT D-2508

Joint Staff	**No. of Copies**
Joint Staff, J8 8000 Joint Staff Pentagon Washington, DC 20318-8000	
ATTN: SAMD	
Mr. Jeffrey Rogers	1
LtCol Edwards	1
JCIDO	
Col Madison	1
Joint Staff, J6 6000 Joint Staff Pentagon Washington, DC 20318-6000	
ATTN: Tech & Arch Div	
LTC Vye	1
Defense Agencies	
DARPA Tactical Technology 3701 N. Fairfax Drive, Room 829 Arlington, VA 22203-1714	
ATTN: Dr. Mark McHenry	1
Other Organizations	
Defense Technical Information Center 8725 John J. Kingman Road, STE 0944 Fort Belvoir, VA 22060-6218	2
Institute for Defense Analyses 1801 N. Beauregard Street Alexandria, VA 22311-1772	15

(This page is intentionally blank.)

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 2000	Final

4. TITLE AND SUBTITLE
MOUT Situational Awareness Experiments

5. FUNDING NUMBERS
CRP 1072

6. AUTHOR(S)
Dennis F. DeRiggi, Richard W. Carpenter, Keith L. Green, Windsor W. Lin, Timothy M. Stone

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Institute for Defense Analyses
1801 N. Beauregard Street
Alexandria, VA 22311-1772

8. PERFORMING ORGANIZATION REPORT NUMBER
IDA Document D-2508

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
FFRDC Programs
2001 N. Beauregard Street
Alexandria, VA 22311-1772

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Public release/distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Military Operations in Urban Terrain present challenges that differ from those of conventional warfare. Often these arise because only limited force can be applied. To compensate, precise information about an opponent's location and condition is desired. This experiment demonstrates the value of such information when an occupied building is approached by coordinated Blue force, but calls into question its utility once inside.

14. SUBJECT TERMS
MOUT, situational awareness, dismounted infantry, experimental design

15. NUMBER OF PAGES
50

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMIT OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	Unlimited